BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

I. IDENTIFICATION PAGE

In re Application of:	:	Before the Examiner:
Tour et al.	:	Wong, Edna
Serial No.: 10/738,459	:	Group Art Unit: 1753
Filed: December 17, 2003	:	Conf. No.: 9579
Title: USE OF MICROWAVES TO CROSSLINK NANOTUBES	:	

REPLY BRIEF

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Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

II. STATUS OF CLAIMS

Claims 1-27 are pending in the Application. Claims 1-27 are rejected. Claims 1-27 are appealed.

III. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The following are the remaining grounds of rejection to be reviewed in light of the Examiner's withdrawal of rejections as stated in the Examiner's Answer to Applicant's Appeal Brief:

A. Whether Claims 1-4 and 7 are unpatentable under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") or in the alternative obvious under 35 U.S.C. §103(a) over Harutyunyan.

B. Whether Claims 8-9, 11-15 and 18 are unpatentable under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") or in the alternative obvious under 35 U.S.C. §103(a) over Harutyunyan.

C. Whether Claims 19, 21-24, and 27 are unpatentable under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") or in the alternative obvious under 35 U.S.C. §103(a) over Harutyunyan.

D. Whether Claims 5 and 6 are unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") in view of Fliflet *et al.* "Application of Microwave Heating to Ceramic Processing: Design and Initial Operation of a 2.45-GHz Single-Mode Furnace," IEEE Transactions on Plasma Science, Vol. 24, No. 3, June 1996, pp. 1041-1049 ("Fliflet").

E. Whether Claim 10 is unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") in view of Holtzinger *et al.* "Sidewall Functionalization of Carbon Nanotubes," Angew. Chem. Int. Ed. Engl., 2001, Vol. 40, No. 21, pp. 4002-4005 ("Holtzinger").

F. Whether Claims 16 and 17 are unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") in view of Fliflet *et al.*

"Application of Microwave Heating to Ceramic Processing: Design and Initial Operation of a 2.45-GHz Single-Mode Furnace," IEEE Transactions on Plasma Science, Vol. 24, No. 3, June 1996, pp. 1041-1049 ("Fliflet").

G. Whether Claim 20 is unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") in view of Holtzinger *et al.* "Sidewall Functionalization of Carbon Nanotubes," Angew. Chem. Int. Ed. Engl., 2001, Vol. 40, No. 21, pp. 4002-4005 ("Holtzinger").

H. Whether Claims 25 and 26 are unpatentable under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 7,014,737 to Harutyunyan ("Harutyunyan ") in view of Fliflet *et al.* "Application of Microwave Heating to Ceramic Processing: Design and Initial Operation of a 2.45-GHz Single-Mode Furnace," IEEE Transactions on Plasma Science, Vol. 24, No. 3, June 1996, pp. 1041-1049 ("Fliflet").

IV. ARGUMENT

Applicant uses this Reply Brief to address new argument and/or erroneous content presented in the Examiner's Answer in response to the Appeal Brief. All arguments made previously in the Appeal Brief should be considered in addition to the information that is presented below.

A. Claims 1-4 and 7 Are Not Properly Rejected Under 35 U.S.C. §102(e)/103(a): Harutyunyan

1. Claim 1

Claim 1 is a method for crosslinking carbon nanotubes. The claim has the limitations of (1) providing the nanotubes, (2) irradiating the carbon nanotubes with microwaves, and (3) yielding a plurality of crosslinked nanotubes as a result of irradiating of the carbon nanotubes.

102(e)

Harutyunyan is not irradiating the carbon nanotubes. He is irradiating the impurities located within the carbon nanotubes. The nanotubes are non-participatory spectators during the Harutyunyan irradiation process, i.e. they do not absorb the radiation. In one possible mode disclosed by Harutyunyan, he targets radiation to the metal impurities found in carbon nanotubes, leading to localized heating of the metal impurity and thence to the purification of carbon nanotubes. Alternatively, as the Examiner (Page 19 at item 1) correctly points out, there may also be direct heating of "carbon shells" surrounding the catalyst particle, but this is not targeting the radiation to the carbon nanotubes as explained below.

The Examiner has erroneously equated the "carbon shells" that surround the catalyst particle with the carbon nanotubes (Page 20 and Page 25). Harutyunyan lists the types of carbon impurities that are present in column 2, lines 59-60: "undesirable minority phases, such as amorphous carbon, multishell carbon, and carbon 'onions.'" This is further detailed in column 4, lines 37-42: "the impurities include residual catalyst, amorphous carbon, and carbon shells that encase the residual catalyst. Since the shells encase the residual catalyst, it is desirable to remove or deteriorate the shells so that the residual catalyst can be more readily removed."

Harutyunyan discloses the **purification** of carbon nanotubes (**not crosslinking** as claimed in the present application) by removal of these undesired carbon phases by selective

irradiation of the impurities, whether this is by direct heating of the carbon impurities, or conductive heating by irradiation of the metal catalyst particles. For example see the following passages:

In the Summary of the Invention Column 1:

Lines 20-25: "In one embodiment, the invention provides a process for **purifying** a mixture of nanotubes or nanofibers with particles of a catalyst residue. The process comprises inducing localized heating of the particles by exposing them to electromagnetic radiation or an electromagnetic field, and removing the particles."

In the Description of the Preferred Embodiments:

Column 4, lines 43-48: "To deteriorate the shells, preferably the shells are locally heated, such as by exposure to an electromagnetic field or electromagnetic radiation. In some instances, the localized heating may be direct, in other instances, the residual catalyst may be locally heated, which in turn heats the shell since the shell adjacent [sic] to the catalyst."

Column 5, lines 55-57: "Preferably, the catalyst has slightly different physical properties from the nanotubes or nanofibers that may be exploited to effect localized heating."

Column 5, lines 59-63: "The shape of the residual catalyst particles may also be exploited to produce localized heating by the methodology. The strength of the coupling between the particle and the electromagnetic field is influenced by the shape of the particle and its orientation in the field or cavity."

Column 6, lines 14-18: "When there is a structural similarity between the nanotubes or nanofibers and the outer layer, localized heating of the catalyst particle is a way to generate a difference in reactivity that can lead to selective breach or removal of the outer layers."

Column 6, lines 22-29: "This purification step preferably includes a step of selectively inducing a localized heating in the impurities, and then removing the impurities by a chemical treatment, as discussed below further.

Localized heating of the residual particles may be accomplished by exposing the crude product of a nanotube or nanofiber formation process...to electromagnetic radiation or to an electromagnetic field."

Column 6, lines 44-46: "It is well known that various subatomic, electronic, and molecular constituents of a material may be selectively excited by electromagnetic irradiation."

Column 7, lines 17-25: "The specific frequencies of electromagnetic radiation useful in the present methodology will vary, however, with the composition and structure of the residual particles. Any material as a general rule, can be uniquely characterized by its absorption and emission of electromagnetic radiation. Once the nanofiber and the residual catalyst have thus

been characterized, one of skill in the art will be able to select a frequency of electromagnetic radiation that will induce localized heating of the residual catalyst particles.

Column 7, lines 38-42: "Those of skill in the art will readily determine whether residual particles of a particular composition have been selectively heated in the presence of nanotubes or nanofibers of a particular composition. Such a determination *might* be based on the degree of degradation, if any, of the structure or composition of the nanotubes or nanofibers after exposure to an electromagnetic field or radiation."

These quotes are but a few examples of the targeted irradiation of the impurities as disclosed by Harutyunyan. Thus, the argument the Examiner makes about carbon nanotubes absorbing microwave radiation during the Harutyunyan process are mistaken 1) because the conflation of carbon shells with carbon nanotubes is erroneous and 2) Harutyunyan has laid out conditions for assuring that the nanotubes or nanofibers are not subjected to the radiation by selective irradiation of the impurities. This in turn, causes localized heating of the impurities (predominantly the metal impurities).

Regarding the Examiner's question: wouldn't the microwave radiation strike some of the carbon nanotubes?: The answer is no. The selectivity imposed by the conditions that Harutyunyan places on the system avoid providing the carbon nanotubes with absorbable radiation. Applicant's refer the Examiner to Column 6, lines 44-46 shown above.

(B) By contrast, the Applicant is irradiating the **carbon nanotubes** to effect their crosslinking. The Applicant's method, supplies radiation to the **carbon nanotubes**, resulting in crosslinking of the nanotubes.

Of the stated limitations, Harutyunyan only provides carbon nanotubes. He does not supply them with microwave radiation to cause their crosslinking. Therefore Claim 1 is not anticipated and is patentable over Harutyunyan. Thus, withdrawal of this rejection is respectfully requested.

103(a)

Applicant reiterates, carrying out the irradiation in the manner of Harutyunyan is useful for **purifying** carbon nanotubes. Crosslinking nanotubes, by Applicant's procedure, destroys the very operational purpose of Harutyunyan, to isolate purified carbon nanotubes. The proposed modification cannot change the principle of operation of the prior art being modified.

In the Examiner's Answer on page 22, 3rd paragraph the Examiner has mischaracterized Harutyunyan by oversimplifying the method disclosed in the citation. Harutyunyan does not merely disclose irradiation of the carbon nanotubes plus metal catalyst. The irradiation is selective and localized to the impurities. The nanotubes in the Harutyunyan process are a non-participatory entity during irradiation because of the selectivity of absorption imposed on the system. The nanotubes are not absorbing the radiation in the Harutyunyan process. In the Applicant's process the nanotubes are absorbing the radiation. Harutyunyan discloses that one of skill in the art will recognize the ability to perform such selective irradiations. See Column 7, lines 17-25 above.

In the Examiner's Answer on page 23 the Examiner states that the method steps are similar and thus expected to provide products with inherently the same properties. Applicant respectfully points out the Examiner's statement is not accurate. Harutyunyan selectively irradiates the impurities allowing for their facile removal and securing of purified nanotubes. Applicant irradiates the carbon nanotubes to cause their crosslinking. That completely different compositions are being irradiated necessarily dictates that the products will be different!

The Examiner has suggested twice on page 24 of the Examiner's Answer that no modification of the Harutyunyan process is necessary to arrive at the Applicant's process. This is also not a correct statement. The two processes target completely different compositions with the microwave radiation. The modification to Harutyunyan is to take away the selective irradiation of the impurities and supply microwave radiation to the carbon nanotubes. Two completely different compositions are being irradiated in the two processes.

Finally, the Examiner has not established a *prima facie* case of obviousness because (1) there is no rational underpinning, suggestion, or motivation to modify Harutyunyan to crosslink nanotubes; (2) Harutyunyan teaches away from crosslinking nanotubes; his purpose is to secure purified carbon nanotubes; and (3) Harutyunyan does not teach the limitations of irradiating carbon nanotubes, nor obtaining crosslinked nanotubes. Harutyunyan only provides carbon nanotubes and a means of purifying them by a method to selectively remove residual catalyst and other carbonaceous species.

Accordingly, Claim 1 is not obvious and is patentable over Harutyunyan. Applicants request withdrawal of this rejection.

2. Claim 2

102(e)/103(a)

Claim 2 incorporates all the limitations of Claim 1 and is therefore, patentable for at least the same reasons. Applicants request withdrawal of this rejection.

3. Claim 3

102(e)/103(a)

Claim 3 incorporates all the limitations of Claim 1, and is therefore, patentable for at least the same reasons. Applicants request withdrawal of this rejection.

4. Claim 4

102(e)/103(a)

Claim 4 incorporates all the limitations of Claim 1, and is therefore, patentable for at least the same reasons. Applicant's request withdrawal of this rejection.

5. Claim 7

102(e)/103(a)

With regard to Claim 7 (and Claim 8, page 28, Claim 11,page 30, Claim 12, page 31, Claim 18, page 32, Claim 21 and 22, page 34, Claim 27, page 35), on page 27 of the Examiner's Answer the Examiner suggests that the interaction of the carbon nanotubes with microwave radiation is inherent by performing the method steps and that "to yield a plurality of crosslinked nanotubes" does not point to any special or critical circumstance or method condition that distinguishes it from the prior art. Applicant's respectfully disagree with this statement. Implicit in this latter portion of the claim is the fact that the carbon nanotubes are actively **absorbing** the microwave radiation that is being supplied. Absorbing the supplied radiation is an active step. This contrasts with the cited art in which the carbon nanotubes are **not absorbing** the microwave radiation that is being supplied. Thus, this represents an important and functional limitation in the method claim language. Applicants request withdrawal of this rejection.

B. Claims 8-9, 11-15 and 18 Are Not Properly Rejected Under 35 U.S.C. §102(e)/103(a): Harutyunyan

1. Claim 8

The Examiner has maintained rejections of Claim 8 for the similar reasons cited for maintaining the rejections of Claim 1. Applicant's arguments in the Appeal Brief stand along

with arguments presented above: See arguments presented in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

2. Claim 9

102(e)/103(a)

Claim 9 incorporates all the limitations of Claim 8 and is therefore, patentable for at least the same reasons. Applicants request withdrawal of this rejection.

3. Claim 11

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

4. Claim 12

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

5. Claim 13

102(e)/103(a)

Claim 13 incorporates all the limitations of Claim 8 and is therefore patentable for at least the same reasons. Applicants request withdrawal of this rejection.

6. Claim 14

102(e)/103(a)

Claim 14 incorporates all the limitations of Claim 8 and is therefore patentable for at least the same reasons. Applicants request withdrawal of this rejection.

7. Claim 15

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

8. Claim 18

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

C. Claims 19, 21-24, and 27 Are Not Properly Rejected Under 35 U.S.C. §102(e)/103(a): Harutyunyan

The arguments presented above in Claims 1 and 8 apply to Claim 19. Applicants request withdrawal of this rejection.

2. Claim 21

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

3. Claim 22

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

4. Claim 23

102(e)/103(a)

Claim 23 incorporates all the limitations of Claim 19 and is therefore patentable for at least the same reasons. Applicants request withdrawal of this rejection.

5. Claim 24

102(e)/103(a)

Claim 24 incorporates all the limitations of Claim 19 and is therefore patentable for at least the same reasons. Applicants request withdrawal of this rejection.

6. Claim 27

Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 7. Applicants request withdrawal of this rejection.

D. Claims 5 And 6 Are Not Properly Rejected Under 35 U.S.C. §103(a): No. Harutyunyan in view of Fliflet

The Examiner has not provided adequate reasoning why one skilled in the art would be guided to exchange of the TE103 microwave source with the NRL 2.45 GHz microwave furnace. That the alternative exists in the art does not provide the impetus for making the exchange. That is to say, if Harutyunyan's process performs functionally with a 150W source to achieve the

removal of metal and carbonaceous impurities, what is the motivation for switching to a source capable of providing up to 6kW power? Harutyunyan doesn't need a magnetron-based source with 1.5 kW power to accomplish his purification. There is no rational underpinning presented by the Examiner in this regard and it therefore appears that the Examiner is merely using hindsight reconstruction to arrive at the claimed subject matter.

All the reasons for the patentability of independent Claim 1 over Harutyunyan are incorporated herein and Claims 5 and 6 are patentable for at least those stated reasons. Applicant's arguments in the Appeal Brief stand along with arguments presented above. Applicants request withdrawal of this rejection.

E. Claim 10 Is Not Properly Rejected Under 35 U.S.C. §103(a): Harutyunyan in view of Holtzinger

In the Examiner's answer (page 38, first paragraph) the Examiner has erred again in equating the impurity carbon shells with carbon nanotubes. The Examiner quotes from a section of Harutyunyan describing how the shells are degraded to assist in removing the residual catalyst. This has nothing to do with the chemical derivatization taught by Holzinger. That Holzinger on its own teaches improved solubility and thus processibility by functionalizing nanotubes does not render Claim 10 obvious. Solubilization of the tubes is not necessary (and possibly detrimental depending on the solvent) for performing the crosslinking process of the Applicant.

All the reasons for the patentability of independent Claim 8 over Harutyunyan are incorporated herein and Claim 10 is patentable for at least those stated reasons. Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1. Applicants request withdrawal of this rejection.

F. Claims 16 And 17 Are Not Properly Rejected Under 35 U.S.C. §103(a): Harutyunyan in view of Fliflet

See section D above for Claims 5 and 6 because the same argument applies.

All the reasons for the patentability of independent Claim 8 over Harutyunyan are incorporated herein and Claims 16 and 17 are patentable for at least those stated reasons. Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 8. Applicants request withdrawal of this rejection.

G. Claim 20 Is Not Properly Rejected Under 35 U.S.C. §103(a): Harutyunyan in view of Holtzinger

See section E above for claim 10 because the same argument applies.

All the reasons for the patentability of independent Claim 19 over Harutyunyan are incorporated herein and Claim 20 is patentable for at least those stated reasons. Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 19. Applicants request withdrawal of this rejection.

H. Claims 25 and 26 Are Not Properly Rejected Under 35 U.S.C. §102(b)/103(a): Harutyunyan in view of Fliflet

See section D above for Claims 5 and 6 because the same argument applies.

All the reasons for the patentability of independent Claim 19 over Harutyunyan are incorporated herein and Claims 25 and 26 are patentable for at least those stated reasons. Applicant's arguments in the Appeal Brief stand along with arguments presented above: See arguments presented above in Claim 1 and Claim 19. Applicants request withdrawal of this rejection.

CONCLUSION

For the reasons noted above, the rejections of Claims 1-27 are in error. Appellants respectfully request reversal of the rejections and allowance of claims 1-27.

Respectfully submitted,
WINSTEAD PC
Agent for Appellants

By: 

Victor Behar, Ph.D.
Reg. No. 60,691

P. O. Box 50784
Dallas, Texas 75201
713.650.2632